PHYS355
Introduction to Biological Physics

Spring 2022
BRK 103

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Class meetings

Classes will meet Tuesday and Thursday from 1:00pm to 2:15pm at BRK 103. Except for the first two weeks (10–21 January 2022), the classes will be delivered via Zoom.

Reference Textbooks

There is no required textbook. Following is a list of textbooks that you may find useful.

- Thomas Andrew Waigh, *The Physics of Living Processes*, John Wiley & Sons (2014).
- Philip Nelson, *Biological Physics*, W. H. Freeman and Company (2014).
- M. Daune, *Molecular Biophysics: Structures and Dynamics*, Oxford University Press (1999).
- L. Stryer, *Biochemistry*, 5th ed., W. H. Freeman, New York (2003).
- Cantor and Schimmel, *Biophysical Chemistry, I, II, III*, W. H. Freeman, New York (1980).

Course Description

This course will cover fundamentals of biological physics. The basic concepts will first be reviewed. Biomolecules and their functions will be covered. Cells and their components will be visited briefly. Random walks and polymer physics models and their application to biological systems will be described. Entropy and energy concept and their roles in biological systems will be discussed. Molecular and cellular mechanics will be introduced. Experimental techniques such as single molecules techniques and their applications to biological molecules will be presented. Finally, the physics of cancer will be introduced.

Important Dates

11 January 2022	First day of classes
10 February 2022	Spring Recess, no classes
12–20 March 2022	Spring Break, no classes
21 April 2022	Last day of classes

Honor Code

The Rice Honor Code applies.

Homework Policy

Homework assignments will be given every week on Thursday. Homework will be due the following Thursday in the beginning of class. Late homework will not be accepted. You are allowed to collaborate with fellow students on your homework. You may not consult answer keys (from previous years, *etc.*). The homework you turn in must represent your own understanding.

Midterm Report

The midterm report is a short report on the subject, of the paper(s) you choose to present in class. The selected topic/paper must be related to biological physics. Detailed instructions about the midterm report will be given later in the semester.

Final Presentation

Each person will give a 30 minute presentation in class. The presentation topic should be chosen from a list given in class.

Credit

Homework	30 %
Midterm report/class project	30 %
Final presentation	40 %

Tentative Outline of the Course

DNA
RNA
Proteins
Cells
Bacteria
Eukaryotic systems
Virus
Brownian motion
Random walks
Polymer physics models of biomolecules
Single molecule techniques
Cancer and other diseases

Course Objectives: Students should learn

- The fundamentals of nucleic acids and proteins [Course outcomes 1–2]
- To apply methods for solving the protein folding problems [Course outcomes 2–3]
- To apply methods for quantifying reactions involving bacterial cells and viruses at the molecular and cellular levels [Course outcomes 4–5]
- To apply governing equations for Brownian motion and random walks [Course outcomes 6]
- To apply governing equations to calculate persistence length[Course outcomes 7]
- The technique and information obtained from single molecule biophysics experiments [Course outcomes 8]
- Cancer physics [Course outcomes 9]
- Understanding and communicating modern biological physics topics [Course outcomes 10]

Course Outcomes: Students completing the course should be able to

- Describe the structure and function of nucleic acids
- Describe and illustrate the structure and function of proteins
- Calculate protein folding thermodynamics and kinetics
- Estimate molecular quantities and reactions in bacterial cells
- Describe virus building blocks, function, and life cycle
- Calculate Brownian motion and random walks
- Calculate persistence length in polymer physics models
- Describe the technique and information obtained from single molecule biophysics experiments
- Describe cancer physics
- Perform literature search for modern biological physics topics and communicate the findings to peers

If you have a documented disability that will impact your work in this class, please contact me to discuss your needs during the first two weeks of class. Additionally, you will need to register with the Disability Support Services Office in the Ley Student Center.